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whether the subject taught be arithmetic or the theory of functions. We are thoroughly convinced that the value of this unification and coöperation makes the effort put forth to obtain it seem very slight in comparison. We are also convinced that there are other beneficial effects of this effort which are less apparent but not less important. And, finally, we believe that any college or university that has done little or no work of this sort will find it highly worth while to increase its activity in this direction.

BOOK REVIEWS.

EDITED BY W. H. BUSSEY, University of Minnesota.

Analytic Geometry. By L. WAYLAND DOWLING and F. E. TURNEAURE. Henry Holt and Co., New York, 1914. xi + 266 pages.

A chief feature of several recent texts on analytics is the emphasis of the general idea of a function and its graph rather than of the theory of conics. This text retains that emphasis to a large extent. After 25 pages devoted to chapters on "Systems of Coördinates" (I) and "Directed Segments and Areas of Plane Figures" (II), we find 65 pages of discussion of "Functions and their Graphic Representation" (III), "Loci and their Equations" (IV), and "Equations and their Loci" (V), the last chapter including "Transformation of Coördinates." In Chapter III first methods of graphing functions are given with illustrations from algebraic and transcendental functions in rectangular and polar coördinates. The equation of a locus is defined in Chapter IV and the standard equations of straight lines, the conics and Cassinian ovals are derived for both coördinate systems. Chapter V gives methods of discussing an equation with numerous examples. It is not until Chapter VI, "Loci of First Order," beginning on page 98, that we find a systematic treatment of the straight line. After what has preceded, 10 pages suffices. Then in Chapter VII, "Loci of Second Order, Equations in Standard Form," we find, compassed in 34 pages, a fairly complete elementary treatment of the conics, including "Poles and Polars" and "Systems of Conics." The next chapter treats the general equation of second degree.

In accord with another modern development, we find (included in Chapter IX, "Loci of Higher Order and Other Loci") a twelve page discussion of "Empirical Equations and their Loci." This subject, on account of its importance in applications of mathematics to the sciences, seems destined to become an essential part of a good course in analytics. The presentation of the authors, which includes the use of logarithmic coördinate paper, is excellent.

Following these chapters on plane analytics is a brief treatment (about 50 pages) of solid analytics. There is little of novelty in this part of the book.

The book as a whole impresses one very favorably. The general order of presentation is excellently adapted to give the student a real appreciation of the power and beauty of analytic geometry, and also the ability to use it. The tendency to lay a little more stress than usual on the geometrical aspect of the subject, especially in the chapter on "Loci and their Equations," by numerous figures and by various methods of constructing some of the loci, will be welcomed by many teachers.

There are several matters of detail, however, which one may criticise. Exceptional cases of various sorts are, for example, quite generally ignored. Thus in discussing the two-point form of the equation of a straight line, the exceptional cases of lines parallel to either coördinate axis receive no mention. In giving the slope forms, no mention is made of lines parallel to the y-axis. And all lines through the origin are ignored in connection with the intercept and normal forms. The determinant form of the equation of a plane through three points is said to be linear without mentioning the exceptional case arising when the points are collinear. Likewise no account is taken of exceptional cases in the discussion of pencils of lines or of conics.

While the general idea of Chapter IV, "Loci and their Equations," appeals to me, the logic seems unsatisfactory in two respects. By definition, "The equation of the locus of a point is an equation in the variables x and y which is satisfied by the coördinates of every point on the locus; and conversely. . . ." The "*and conversely*" is subsequently neglected without comment in deriving equations except in the case of the circle. This, of course, invalidates the proof, for instance, that the locus of every equation of first degree is a straight line. The proof of the "*and conversely*" for a straight line is as difficult as the direct, and the omission seems hardly excusable. The second criticism is on the expression, "*the* equation of the locus . . ." without comment on the first "*the*." There is an infinite number of equations satisfying the prescribed conditions in general, and some remark is apparently necessary before one of them may be designated as "*the* equation." For example, the following are all equations of the same real locus:

$$x^2 + y^2 = 4; \quad x^4 + 2x^2y^2 + y^4 = 16;$$

$$9x^2 + 9y^2 = 36; \quad x^4 + x^2y^2 + 4y^4 = 16.$$

At least a footnote of explanation seems desirable.

It is further noted that the proof of the formula for the distance from a line to a point (p. 104) is invalid for some cases (e. g., for Fig. 66, p. 105).

As a minor point for criticism, one is surprised to find that the formula for the distance between two points is not given for rectangular cartesian coördinates as distinct from oblique coördinates. Also no reason for deriving formulas for the mid-point of a line segment by a method different from that required to find the point of division in a given ratio, r, is apparent since the former is a simple corollary of the latter. And although the latter is given in the usual manner, it is open to a certain criticism. A point P is found on P_1P_2 such that $P_1P/PP_2 = r$; its coördinates are

$$x = \frac{x_1 + rx_2}{1 + r}; \quad y = \frac{y_1 + ry_2}{1 + r}.$$

There is such a point for all values of r *except* $r = -1$; and by taking all values of r we get all points on the line P_1P_2 *except* P_2. These exceptional cases are avoided and we get simpler formulas, which are more easily derived, if we determine P such that $P_1P/P_1P_2 = r$ as follows; namely[1]

$$x = x_1 + r\cdot\Delta x = x_1 + r(x_2 - x_1), \qquad y = y_1 + r\cdot\Delta y = y_1 + r(y_2 - y_1).$$

To sum up, although marred by several inaccuracies in detail, the book as a whole is very good, thoroughly modern, and includes much in a small compass.

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The Algebra of Logic. By LOUIS COUTURAT. Authorized translation by LYDIA G. ROBINSON, with a preface by PHILIP E. B. JOURDAIN. The Open Court Publishing Co., Chicago, 1914. xiv + 98 pages. $1.50.

This volume is a translation of volume number 24 in the Gauthier-Villars collection under the general title Scientia. These very useful manuals run about 100 pages each, in two series, the present number belonging to the physico-mathematical series. The translation has been well done although it is not exactly a literal rendering of the French style of sentence. A bibliography has been inserted and the preface presents, in brief form, a good history of the development of symbolic logic. These additions are distinct improvements and will make the book more useful.

The algebra of logic, as its name indicates, is a mathematical treatment of logic. It is not a new species of numerical calculation by symbols, but is a treatment of the field of logical notions by introducing symbols which have to be combined according to definite laws. It is an application of the methods of mathematics to logic, and is just as much applied mathematics as is mechanics. The only peculiarity in the situation is that in the reasoning processes employed, the symbols and laws relate to the reasoning process itself. The field of study in logic consists of classes of objects of the mind as marked by some distinguishing quality and the relations between such classes; assertions regarding mental objects and their relations; and relations themselves as objects with relations to each other. For example we may study the class of triangles that are distinguished as isosceles, and the class that are distinguished as having two equal angles. The identification of the two classes is done by logical processes. If we consider the problem of identification of classes of objects in general we are studying logic. Just as no one can get along in the world without using arithmetic consciously or unconsciously, so no one can get along without reasoning. If he becomes interested in the processes of arithmetic and the study of identities between numerical expressions in general, then he begins to study algebra. So too if he becomes interested in the process of reasoning he begins to study logic, and the most efficient way to do this is to apply the mathematical method; that is to say, to devise a system of symbols that will take the place of the mental objects under study, to parallel the mental combinations of these objects with

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[1] These formulas are given, for example, by Ziwet and Hopkins, *Analytic Geometry*, p. 8.